AMRAD NEWSLETTER

Amateur Radio Research and Development Corporation

December 1981

OUR DECEMBER 7 MEETING will be the annual meeting. There will be a summary of 1981 accomplishments and some discussion of ideas for 1982 projects. The meeting will be from 7:30 to 9:00 P.M., at the Patrick Henry Branch Libary, Vienna, VA.

Elections will be held for 3 directors and 2 alternates for the year 1982. The following candidates were nominated at the November 2 meeting:

Richard Barth, W3HWN
David W. Borden, K8MMO
Robert E. Bruninga, WB4APR
Terry L. Fox, WB4JFI
Paul L. Rinaldo, W4RI
Elton A. Sanders, Jr., WB5MMB

THE JANUARY 7 MEETING will be a talk by George Lemaster on various TV captioning systems, including those for the deaf. We will have a sign-language interpreter there.

OUR FEBRUARY 1 MEETING will be a status report and discussion of amateur spread spectrum experimentation. This time is chosen because we are due to submit a report of the AMRAD SS tests by March 1, 1982. All those interested in spread spectrum should read the FCC Notice of Inquiry and Proposed Rule Making, General Docket No. 81-414 which appeared in the November newsletter.

AMRAD MAILING LABELS ARE COMPUTERIZED at long last, thanks to Bill Pala, WB4NFB. Take a quick look at the label on this newsletter and report any discrepancies to Bill as soon as possible. Note that the month and year of your membership expiration is in the upper left-hand corner of the label. If your membership has expired or is about to do so, please renew your membership now, using the form in the back of the newsletter. Please send all membership forms to Bill Pala -- not to Gerald Adkins, who is staying on as treasurer but dropping the membership chairman function. Thanks to N4GA for his many years of handling memberships. Starting next month, the word RENEW will appear on the labels when it is time for you to renew.

AMRAD DUES are being raised effective January 1, 1982, as decided at the board of directors meeting on November 17, 1981. *(AMRAD dues are set by the Bylaws. Amendments to the Bylaws shall require majority vote of the Board of Directors. Notice of an amendment which has received such approval shall be circulated to the Members. The amendment shall take effect thirty days after said notice unless written objection is received from at least ten percent of the membership. In that case, a vote shall be taken. Approval of the amendment shall then require a simple majority of those Members present at a meeting.)*

The new dues structure will be as follows:

	Annual	Life
Regular	$15	$180
2nd in family at same address	6	96
Full-time student	5	-

In addition, the board of directors voted to continue the acceptance of new life memberships only through the end of next year (1982). This was done in order to limit long-term financial obligations to manageable proportions.

The board took these actions to ensure that we have enough income to continue our present membership services (newsletter costs run about $400 per month for printing and mailing) and to finance a few high priority projects such as keeping the fm voice repeater going and picking up a portion of the costs of new packet repeaters.

Meanwhile, if you would like to extend your AMRAD membership or apply for life membership at the present rates (see form on last page), then you can do so if you mail your check to us before January 1, 1982. So, check your mailing label immediately so that you can decide whether to renew now or wait until sometime in 1982 to renew.

The January issue will include increases in additional postage that members residing at non-U.S. addresses will pay. Postage rates have gone up about 10% for both domestic and overseas mail during 1981.

PROTOCOL

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NEWS

The *snake oil* business has been going better than I ever expected. John, K3HOI and Jon, KE3Z are new local packet board buyers whom we may hear on the local area net soon. The New Jersey gang also ordered several boards, and Norfolk, VA has two new users. Snake oil is difficult to dispense however. I have to go to the post office to mail a board and chip set, and that is the difficult part of the procedure, given my schedule. If anyone ordered anything, please be patient. This enterprise is not a business. I maintain a stock of stuff to get local people started.

In the software department, a hardware failure of my TNC board took me off the air for a few days. My trusty Radio Shack PROM sockets gave up totally and would no longer grab the TIP and LIP PROMS properly. So I constructed a new TNC board using zero-insertion-force (ZIF) sockets for the PROMs. It of course did not work on powering up. The standard power-on checks mentioned in the June 1981 Protocol column revealed that all was good except that the program was not running. I suspected my soldering (always under suspicion) but could see no shorts. I used my ohm meter to "ring out" the data/address lines running between the RAMs and ROMs. I found the short easily then. What looked like a pile of rosin was really solder. After fixing that problem, I again returned to the software department. I was concerned about the LIP software. The local gang here has documented problems with it. So I implemented San Francisco's newest LIP as supplied by Hank, KA6M at our recent conference. I made several changes. First, I included the AMRAD code to allow selecting the cw i-d speed on reset. Then I added our slow-transmit-relay code (transmitter turns on then delays before sending packet). Last, I changed the single-frequency packet repeater code to allow 61 addresses (double the original code). This last change was made after calling Hank (the designer/author of the scheme) who approved the new code. I than sent the new PROMs to the local users, and we are currently checking it out. It looks good at first usage.

I have lots of requests for software. I am going to delay those requests until I get our new TIP off the ground. The one that I am testing was written by Calvin Teague, K6HWJ. It changes the control code idea to special sequences. This idea is a way of making the TIP transparent to the characters being sent through it. Another change that was made was the call sign sign on/off. Previously, one typed the call sign of the station with which you desired to communicate, padding it with spaces to six characters. Everything typed was upper case. The new TIP allows typing lower-case characters and pads for you. The flow control to the 8250 serial port was changed so that when clear-to-send (CTS) goes false, the board sends no characters to the terminal. Also, request-to-send (RTS) now goes low when the terminal input buffer becomes full and control s is sent to the data source. This should make *host mode* work better than before, and I will be testing this.

I got a call from ARRL headquarters (Ed Kalin, K1RT who took over the packet radio board that the League owns). I will be shipping him software any day now. He will get the station running at his house and then at the League headquarters. This is an hf link planned with Bill, W4MIB.

Regarding networking of our various repeaters, Hank, KA6M has sent me a copy of the new routing algorithm for ARPANET. It looks great, but I must study it carefully. The scheme uses a distributed, adaptive-routing scheme that I have always liked. How ARPANET implements it is what is complicated. As Hank points out, it is a good place to start.

LOCAL AREA NETWORK REPEATERS

Jon Bloom, KE3Z is working on a regenerative repeater that uses two Bell 202 modems and a *state* machine (circuit that regenerates data). Two frequencies are employed, but voice is not repeated. A watchdog timer will be set for the longest packet expected (typically 3-5 seconds),and a cw i-d will be provided by another state machine. This would really make our packet throughput increase over the single-frequency machine at the cost of a duplexer. I have requested that no autopatch be connected to this new machine... packets only! I am looking forward to Jon's implementation of this scheme. Maybe we can give it a go on 220 MHz.

□

Coding and Decoding in the W9JD ARQ System

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This article will describe, in general terms, the coding and decoding schemes used in the W9JD FEC ARQ System. All operations are accomplished in software. Readers interested in a complete explanation of the theory behind block codes and why they work should consult a reference.[1]

BLOCK CODING

The W9JD FEC ARQ System uses a twice-interleaved (15,9) Reed-Solomon code. This class of codes was first identified by Reed and Solomon about 1960 and represents a special case of what are known as Bose-Chaudhuri-Hocquenghem (BCH) codes - which in turn are one type of block code. A block code operates by taking a fixed number of information symbols (4-bit nibbles in this case), computing a fixed number of unique check symbols, and combining these two sequences for transmission as a *block*. By choosing a clever method of computing the check symbols, a code designer attempts to define a code which can correct a maximum number of errors (per block) for a given number of check symbols. The "(15,9)" designation indicates that this code uses a block length (information + check symbols) of 15, and divides each block into 9 information and 6 check symbols. The Reed-Solomon codes are optimum in the sense that they allow correction of the theoretical maximum number of symbol errors per block for a given number of check symbols. An RS (15,9) code can correct a maximum of 3 errors per block.

Implicit in using a Reed-Solomon code of length 15 is that each "symbol" to the code is a 4-bit nibble. Mathematically, the code operates on elements of the Galois Field (a finite field) of 16 elements - designated GF(16). Each element of this field can be represented as one combination of a 4-bit pattern; therefore, nibbles can be conveniently used as "symbols" for this code.

The objectives of this project were to be able to conveniently transfer 7-bit ASCII characters and 8-bit bytes representing computer machine code. This was easily accommodated by interleaving. Rather than 9 *4-bit* symbols, we input 9 *8-bit* bytes to the encoder. It then interprets this sequence as two interleaved sequences of the 4-bit symbols it needs to operate. As output, it produces two interleaved sequences of 6 4-bit symbols - which can be conveniently transmitted as 6 8-bit bytes.

The coding and decoding operations for this code represent a (rather complicated) series of algebraic operations where the "numbers" being manipulated are elements of the finite field of 16 elements - as represented by 4-bit nibbles within the computer.

For our trouble, we gain two major benefits by encoding our data:

(1) We can withstand up to a 20% *nibble* error rate within our communications channel and still *correct* the received blocks to fully accuracy (forward error correction or FEC); and,

(2) With very high confidence, the receiving station will know when a decoded block has been corrected to match the data as sent or when it is still garbled and a retransmission of that block is necessary.

These two capabilities, when embedded within a suitably designed automatic repeate request (ARQ) system, allow error-free transmission of data over a poor communications channel.

MODULES

The major modules and a few of the data structures of the encoder/decoder (software) are diagrammed in Fig. 1.

To encode a block, 9 bytes of data to be transmitted are loaded into the first 9 bytes of the ENCoder BUFfer. Then the ENCODE module is called, and on return the 9 check bytes have been computed to complete the 15-byte block. The block may then be transmitted.

The ENCODE subroutine treates ENCBUF as two interleaved 9-nibble sequences of symbols from GF(16). These are interpreted as 9-term polynomials in GF(16) and a multiplication by the internally stored 6-term GF(16) Reed-Solomon (15,9) generator polynomial is performed to yield a 15-term product polynomial. (This is done independently for each of the two sequences.) The polynomial multiplications are performed via a tapped feedback shift register operating over GF(16) and implemented in software.

The GF(16) ADD and MULT subroutines are used many times throughout all the other modules to perform required "add" and "multiply" operations as defined over GF(16).

To decode a block, the 15-byte received block (perhaps with errors) is loaded into ENCBUF. Then the DECODE module is called. The accuracy of the data is checked, and corrections are attempted if necessary. If the correction process was successful, on return the first 9 bytes in ENCBUF are the true data of the block as sent, and the decoder error flags EFLAG1 and EFLAG2 are both set to 00. If the decoder could not correct the block (there were four or more errors in the received block), EFLAG1 or EFLAG2 will be set to a non-zero value on return.

The decoder first takes the two interleaved 15-nibble GF916) sequences in ENCBUF and algebraically computes "syndromes" SYN1 and SYN2 for each sequence. Using the computed syndromes as input data, the BKM module implements the Berlekamp-Massey algorithm to identify which positions within the received sequences (if any) contain errors. These are stored internally at ERLOC1 and ERLOC2 (ERror LOCations). The Forney module uses the syndrome and error locations values already computed to determine the magnitudes of the errors at each location. (The Forney algorithm is used to accomplish this.) Now that the locations and magnitudes of the errors have been identified, the CORRECT module combines this information, along with the original data in ENCBUF, to correct the received data.

At this point the first 9 bytes in ENCBUF are the data as sent - if the received block had 3 or fewer nibble errors per interleaved sequence. If 4 or more errors occurred in the received data the decoding process will fail in one of several ways and correction will be impossible. In this case one or both error flags are set to non-zero to signal the calling software that ENCBUF still contains garbled data.

SUMMARY

This encoding/decoding scheme required six months of concentrated "spare time" development, and exists as Z80 assembler and machine code. The object code (including all buffers and polynomial storage) occupies 5.5 kbytes. The software encodes or decodes blocks in much less than one 8-bit character time at 110 bit/s, although it has not yet been tested to determine its exact execution time.

REFERENCE

[1]Peterson and Weldon, *Error-Correcting Codes,* 2nd Ed., The MIT Press. 1972.

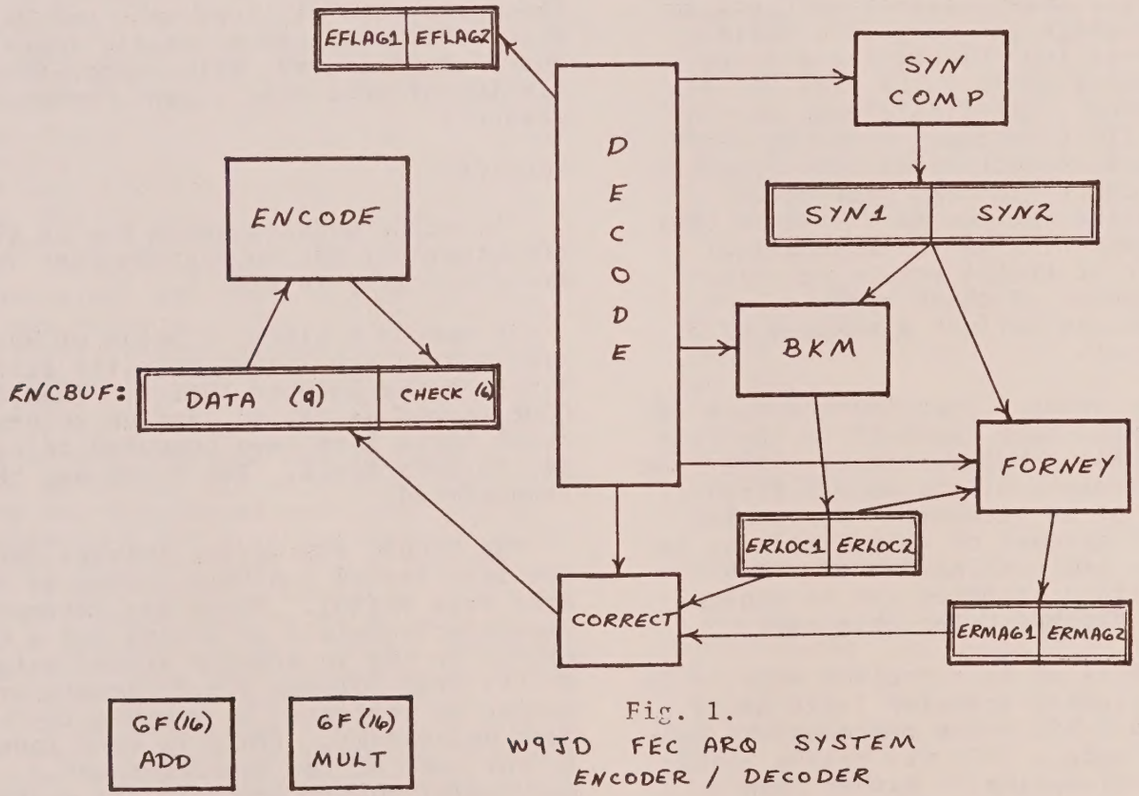

Fig. 1.
W9JD FEC ARQ SYSTEM
ENCODER / DECODER

SPREAD SPECTRUM

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The FCC is moving ahead with its desire to include spread spectrum as a new amateur modulation type. Many of you saw the NOPR carried in the last issue.

The FCC is faced with several interesting issues in considering spread spectrum for ham radio. With the desire to deregulate and allow new advanced techniques comes the need to redefine and enhance traditional approaches to regulation and enforcement

This point was underlined by Tom Clark of AMSAT several months ago at the ARRL's League Planning Meeting which was held in Falls Church, VA. Tom spoke mostly about AMSAT's Phase III program but foresaw the challenge of advanced modulation techniques facing the Commission.

Most important to the Commission is the possibility of interference from wideband "spread" or "swept" signals to both amateur and commercial users. This motivated the inclusion of several steps within the NOPR which should be pointed out.

Specifically, the Commission proposes to:

1. Authorize spread spectrum in three bands - 50-54, 144-148 and 220-225 MHz.

2. Authorize spread spectrum modulation *only* for Advanced and Extra Class licensees.

3. Include questions on spread spectrum in the question set for Advanced and Extra Class tickets.

The above items are configured to adhere to certain international agreements and sharing arrangements with the government. The Commission stated that they will wait to the end of the AMRAD STA before acting on this NOPR.

In looking this over, I would like to offer some comment about items 2 and 3. It goes without saying that the FCC is very concerned about interference possibilities. It appears from the NOPR that they surmise that interference will most likely come from "incorrectly or poorly designed equipment." The NOPR states that "use (of) spread spectrum techniques should be restricted to Amateur Extra and Advanced Class licensees only. The assumption I think the FCC is expressing is that the higher class ticket holders will be less likely than General or Technician class holders to build "dirty" equipment. This forms a perplexing question: does the holding of a "higher class ticket" influence the technical knowledge of the holder beyond a trivial noise factor or the care in which the licensee would conduct on the-air experiments? Perhaps some light can be shed on the problem in light of the experience gained by some of the AMRAD members working under the spread spectrum STA. A lot of experimental activity has been conducted by hams who have higher class tickets and by hams with General class tickets as well. The knowledge which allows them to plan and construct spread spectrum gear is not correlated with the class of license.

The hams who were interested in spread spectrum enough to learn and digest the complex technical literature on the subject are experimenters. This is a special label for a ham to wear in this day. It requires considerable drive and initiative to be a self-starter with this complex technology.

We believe that experimenters are not readily identified by the class of ticket they hold. We do think that the Commission and the amateur community would be well served by allowing Technician and General Class ticket holders of being experimenters as well. Limiting ham radio experimentation to only higher class tickets defeats this goal.

MOBILE FREQUENCY HOPPER

A member of the AMRAD STA group, Chuck Phillips, N4EZV has been quietly working on design of a mobile frequency hopper. Now word comes that the unit is built and that some dummy-load testing has been completed.

As Chuck describes it, it is about as big as a Drake TR-22. It hops on setups which are multiples of 16 discrete frequencies. This means that the unit can be set to hop on 16, 32 or other multiples of 16 channels. Dwell time on any channel is 90 ms. →

Power output is 2 watts. Synchronization between the two units has a simple form. There is a home channel where both units start. When the transmitter is activated on one unit, it sends an audio burst which the receiving unit decodes. This tells both units to start hopping. Hopping takes place over the channels to which both units are programmed.

There is also a look-ahead feature which basically looks a number of channels ahead and watches for speed differences in the hopping of the two units. If the receiving unit looses the transmitting one for a number of consecutive hops a resync procedure is activated and automatic resync is attempted.

Chuck describes some tests that he has tried with two units in his basement, operated on dummy loads. When one unit talks to the other, the sound is clear and not choppy. I have heard choppy sound with other spread spectrum rigs at this hop speed (90 ms). Next Chuck put on a standard vhf receiver which had one channel in the hopping sequence. When Chuck talked into one of the units, it didn't break the squelch on the vhf receiver. When taking the squelch off and listening to the empty channel, all that I was able to hear was a few unintelligible sounds once in a while.

It was interesting that there was a "solid armchair copy" on the FH transceiver but nothing on the vhf receiver. The next experiment was to move the channel separation of one of the FH units 5 kHz to see if the other FH unit would interfere. The answer was no. The two units could be in different worlds for all the interference that they caused each other.

What was amazing to me was how so much processing could be packed into so small a box. Anyway, Chuck is looking forward to some on-the-air tests in the 2-meter band, and Paul, W4RI is working on getting the STA amended for several stations to do this.

I would like to say that Chuck's work represents the first amateur spread spectrum rig built by an Amateur Radio experimenter. It marks an important first step for the spread spectrum experimenters' SIG. Good work, Chuck!

By the way, friends... Chuck has a *General Class* ticket as does this author. □

FOR SALE: TRS-80 Model II. 64k. Perfect condition. With legal copy of CP/M and WordStar plus other utilities & extras. $3,200 cash or trade for Apple II, S-100 components, or letter-quality printer. Also Heath SB200 10-80-meter 1.2-kW linear amplifier. $350 or best offer. Contact Frank Derfler, P.O. Box 691, Herndon, VA 22070. Daytime phone is 202-697-8516.

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FRANK DERFLER, an AMRAD member, has a new book being released by Spectrum Books on December 8 entitled, "Microcomputer Data Communications Systems." It should be available by mid december in local book and computer stores. AMRAD is prominently mentioned. Please ask for it. The price is about $9.00 paperback. Frank will be happy to autograph copies. If his job doesn't take him out of town, he'll be at the January 4, 1982 AMRAD meeting in Vienna, VA.

THE HAMILTON & AREA PACKET NETWORK has a new Bulletin Board for packet-radio info. It is accessible over the air (146.46 connect to VE3PKT) and over the phone on 416-335-6620. Hours are 1800-2200 EST for radio and 1800-0600 EST via phone. Stu Beal says that he hopes to extend the availability to 24 hours per day as soon as he builds a controller for the hard disk that was donated to the network.

THE DEAF AND THE TTY

Barry Strassler
Executive Director
Telecommunications for the Deaf, Inc.
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301-589-3006

FUTURE TECHNOLOGY AND THE DEAF

The U.S. Department of Education has funded a grant under the rehabilitation engineering act. It is too early to know of the new awardee or even the projects that they propose to develop.

What do the deaf need besides improved TDDs (ASCII), radio networking and electronic mail network? The following are ideas for starters:

- lighting devices to warn deaf people in hotel rooms of fire
- visual signaling systems to make heavy industrial machinery safe for deaf machinists
- visual display systems for deaf passengers in buses, trains and airplanes
- improved technological design in hearing aids (amplitude distortion is a major problem)
- paging devices for mothers to call their deaf children playing in the streets
- visual siren detector for deaf drivers
- improved portable communications devices to communicate with the police
- visual displays in drive-in banks and carry-out fast-food stands
- auditory loop systems for theatres, auditoriums and churches, and for deaf children in public schools
- devices for aid to the deaf-blind
- made-for-deaf modifications of such devices as CB radios, pagers, scanners, etc.

All of the above mostly involve ingenuity in electrical/electronic applications, but not necessarily limited to this discipline. There are others: microwaves, laser beams, nuclear engineering (never mind the Three Mile Island fiasco) and yet-to-come but revolutionary innovations. We would think that powers of the human mind can make for-the-deaf modifications of whatever applications that have emerged out of these innovations. □

AMRAD **Amateur Radio Research and Development Corporation**

Membership Application/Renewal

Mail to: Dr. William P. Pala, WB4NFB
5829 Parakeet Drive
Burke, VA 22015

See reverse for overseas mailing rates.

	Annual	Life
Dues: Regular	$12	$120
2nd in family same adr	6	60
Full-time student	3	-

Please make checks payable to AMRAD.

Name_____
Ham Call_____ Home Phone( )_____

Address_____
City,
State/Prov_____ ZIP/PC_____

Class License_____ □ARRL Member
Interests:
□Packet Radio □Spread Spectrum
□RTTY □Deaf TTY
Computer model_____
Microprocessor type_____

I agree to support the purposes of the Corporation.

*Signature*_____

THE AMATEUR RADIO RESEARCH AND DEVELOPMENT CORPORATION is a technically oriented club of about 400 radio and computer amateurs. It is incorporated in the Commonwealth of Virginia and is recognized by the Internal Revenue Service as a tax-exempt scientific and educational organization.

THE PURPOSES OF THE CLUB are to: develop skills and knowledge in radio and electronic technology; advocate design of experimental equipment and techniques; promote basic and applied research; organize forums and technical symposiums; collect and disseminate technical information; and, provide experimental repeaters.

MEETINGS ARE ON 1st MONDAY of each month at 7:30 p.m. at the Patrick Henry Branch Library, 101 Maple Ave E, Vienna, VA. If the 1st Monday is a holiday, an alternate date will be announced in the *AMRAD Newsletter*. Except for the annual meeting in December, meetings are normally reserved for technical talks - not business.

THE WD4IWG/R REPEATER is an open repeater for data communications (including RTTY), voice and experimental modes. It is located at Tyson's Corner, McLean, VA and has excellent coverage. It features a semi-private autopatch available to licensed members. Frequencies are: 147.81 MHz input, 147.21 MHz output. The head of the technical committee is Jeff Brennan, WB4WLW, 7817 Bristow Dr, Annandale, VA 22003, phone 703-354-8541.

THE AMRAD NEWSLETTER is mailed monthly to all members and to other clubs on an exchange basis. Technical articles, new product announcements, news items, calls for papers and other copy related to amateur radio and computing are welcome. Honorariums at a rate of $10 per printed page ($20 maximum per author per issue) are paid for original material accepted. Classified ads are free to members. Commercial ad inquiries are invited. The editor reserves the right to reject or edit any portions of the copy. Items should be mailed by the 8th of the preceeding month to Paul L. Rinaldo, W4RI, Editor, 1524 Springvale Ave, McLean, VA 22101; phone 703-356-8918. Full permission for reprinting or quoting items appearing in the *AMRAD Newsletter* is granted provided that credit is given. Mailing is by 3rd Class bulk mail to U.S. addresses and 1st Class to Canada and Mexico. Overseas readers add 96¢ for surface or $7.80 for air mail to annual dues.

THE AMRAD MESSAGE SYSTEM is an S-100 Computerized Bulletin Board System on 703-734-1387, system operator Terry Fox, WB4JFI. Terry's home phone number is 703-356-8334. The system accepts 110, 300, 450 and 600 baud ASCII callers using Bell 103-compatible modems.

THE HANDICAPPED EDUCATION EXCHANGE (HEX) is operated by AMRAD for those involved in education and communications for the handicapped. It accepts both 110/300-baud ASCII and deaf TTY callers. on 301-593-7033. The sysop Dick Barth, W3HWN's home phone is 301-681-7372.

AMRAD OFFICERS for 1981 are:

Gerald Adkins, N4GA	Treasurer
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Paul L. Rinaldo, W4RI	Director President
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THE AMRAD LIBRARY is operated by Tedd Riggs, KC4YN, 8402 Berea Ct, Vienna, VA 22180, phone 703-573-5067. Donations of technical books, magazines, manuals and catalogs are tax-deductible.

AMRAD IS AFFILIATED with the American Radio Relay League (ARRL), the Foundation for Amateur Radio, the Northern Virginia Radio Council (NOVARC) and The Mid Atlantic Repeater Council (T-MARC).

SPECIAL INTEREST GROUPS are formed from time to time. Currently we have SIG's on Deaf Communications and Spread Spectrum Communications. If you are interested in joining or forming a SIG, please contact Bill Pala, WB4NFB, 5829 Parakeet Dr, Burke, VA 22015; phone 703-323-8345.

TRAINING CLASSES are run as needed. Please discuss your training requirements with any Director.

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